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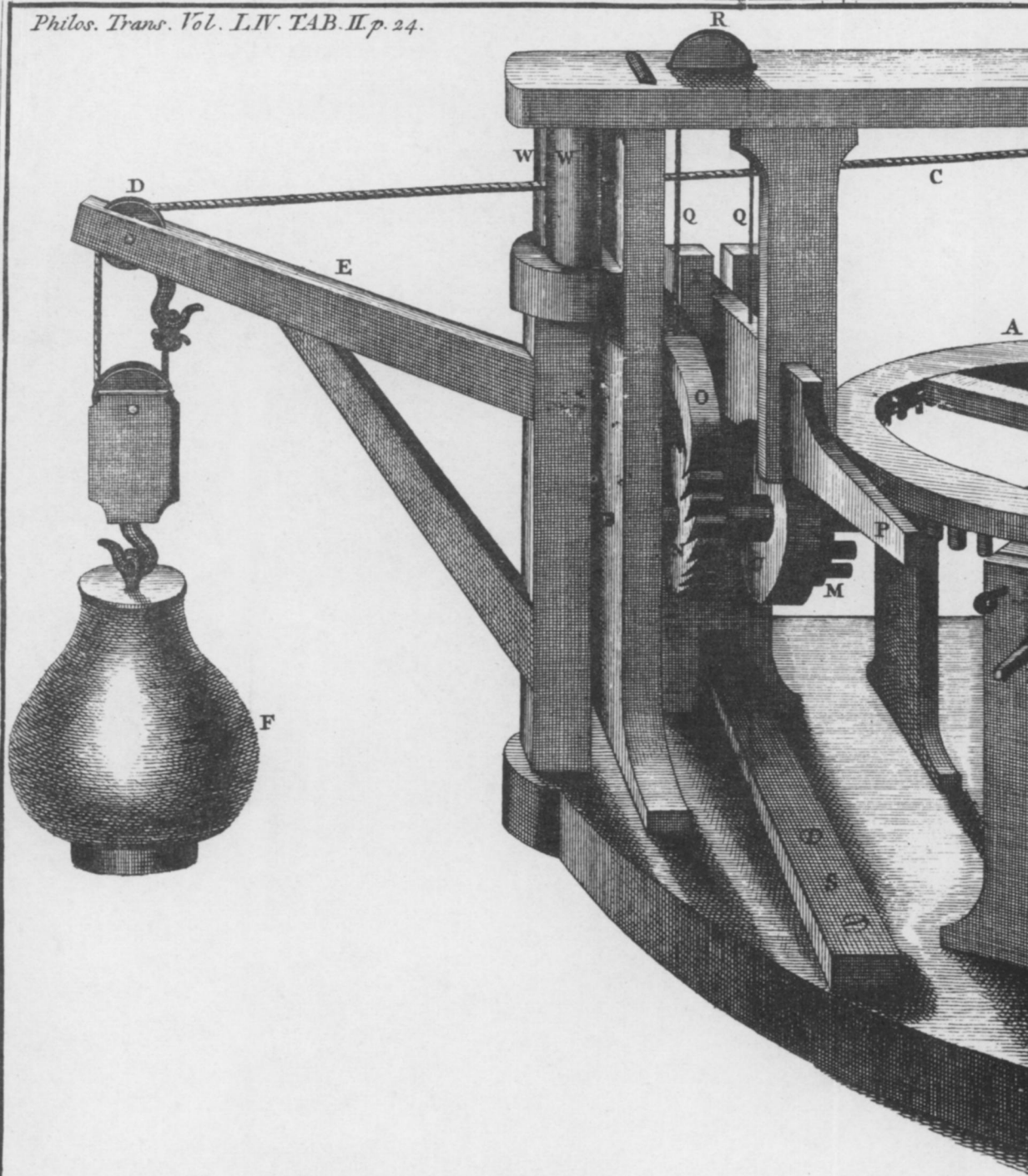
III. *The Description of a new and safe Crane, which has four different Powers; invented by Mr. James Ferguson, F. R. S.*

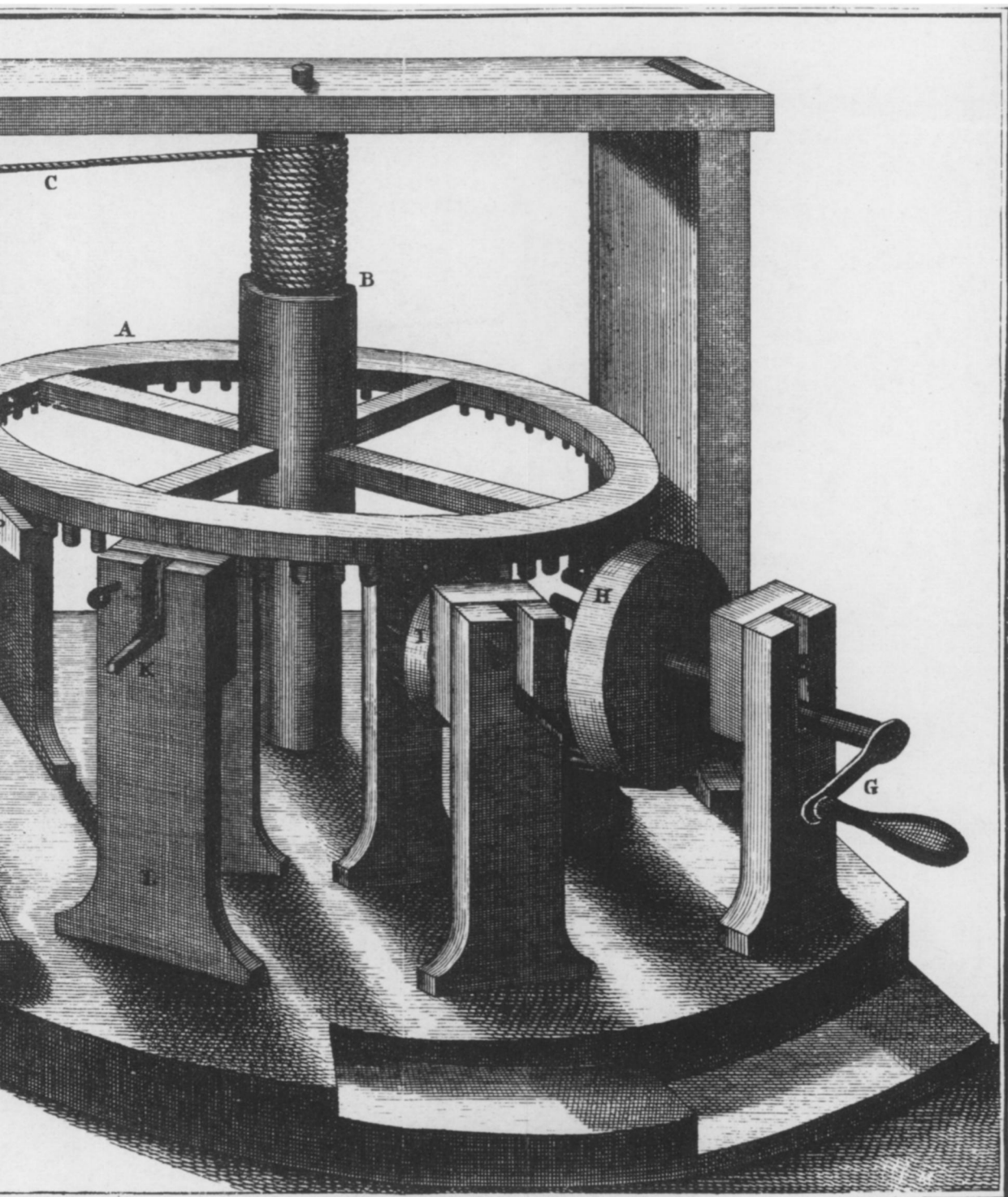
Read Jan. 19,  
1764

THE common crane consists only of a large wheel and axle; and the rope, by which goods are drawn up from ships, winds or coils round the axle, as it is turned by men walking in the wheel. But, as these engines have nothing to stop the weight from running down, if any of the men happen to trip or fall in the wheel, the weight descends, and turns the wheel rapidly backward, and tosses the men violently about within it; which has produced melancholy instances, not only of limbs broke, but even of lives lost, by this ill-judged construction of cranes. And besides, they have but one power for all sorts of weights; so that, they generally spend as much time in raising a small weight as raising a great one.

These dangers and imperfections made me think of a method of remedying them. And for that purpose, I have contrived a crane with a proper stop to prevent the danger, and with different powers suited to different weights; so that there might be as little loss of time as possible: and also, that when heavy goods are let down into ships, the descent may be regular and deliberate.

This crane has four different powers: and, I believe, it might be built in a room eight feet in width; the gib being placed on the outside of the room.





*J. Mynde sc.*

Three trundles, with different numbers of staves, are applied to the cogs of a horizontal wheel with an upright axle ; and the rope, which draws up the goods, coils round the axle. The wheel has 96 cogs, the largest trundle 24 staves, the next largest 12, and the smallest has 6. So that the largest trundle makes 4 revolutions for one revolution of the wheel and it's axle, the next largest makes 8, and the smallest makes 16. A winch is occasionally put upon the axis of either of these trundles for turning it; the trundle being used that gives a power best suited to the weight : and the handle of the winch describes a circle, in every revolution, equal to twice the circumference of the axle of the wheel. So that the length of the winch doubles the power gained by the revolutions of each trundle.

As the advantage gained by any machine or engine whatever, is in direct proportion of the velocity of the power to the velocity of the weight ; the powers of this crane are easily estimated ; and are as follows.

If the largest trundle be turned by the winch, it will make four revolutions for one revolution of the great axle on which the rope coils in drawing up the weight : and as the length of the winch is double the semidiameter of the axle, the power gained will be as eight to one : that is, a man will be able to raise eight times as much weight by means of the engine, as he could do by his natural strength without it ; allowance being made for friction.

If the weight be too great for this power to raise, the second trundle may be turned by the winch, which will turn the wheel and axle twice as slow as

the largest trundle did; because it makes twice as many revolutions for one revolution of the wheel and it's axle: and then the power gained will be as sixteen to one, because the velocity of the power will be sixteen times as great as the velocity of the weight.

If the weight be too great for this power to raise (which we still suppose to be exerted by one man) the winch may be put upon the axis of the third (or smallest) trundle, and then, in turning the winch, the power gained will be as thirty-two to one.

But if the weight should be too great, even for this power to raise, the power may be doubled by drawing up the weight by a double rope, going under a pulley in the moveable block which is hooked to the weight, below the arm of the gib; for then, the power will be as sixty-four to one. If the block has two pullies, and the rope be twice doubled below them, the power will be as 128 to one: and so on, by adding more pullies, according to any required proportion.

Whilst the weight is drawing up, the ratchet-teeth of a wheel slip round below a catch or click that falls successively into them; and so hinders the crane from turning backward, and detains the weight in any part of it's ascent, if the worker should happen accidentally to quit his hold of the winch; or choose to rest himself before the weight is quite drawn up. The catch, in this crane, is constructed much in the same way as in the great crane at Bristol, invented by the late Mr. Padmore, of that city.

In order to let down a weight, the man who works the crane pulls down one end of a lever of the second kind, which lifts the catch out of the ratchet-wheel,

wheel, and gives the weight liberty to descend. But if the descent be too quick, he pulls the lever a little farther down, so as to make it rub against the round edge of a wheel, by which means he lets the weight go down as slowly as he pleases; and, by pulling a little harder, he can stop the weight, if needful, in any part of it's descent. If he accidentally quits his hold of the lever, the catch immediately falls, and stops the whole machine.

In the figure of this crane [TAB. I.] A is the great wheel, and B it's axle on which the rope C coils. This rope goes over a pulley D in the arm of the gib E, and is hooked to the weight F for drawing it up. G is the winch, H the largest trundle, I the next largest, and K is the axis of the smallest trundle, which is supposed to be hid from view by the upright supporter L. M is a trundle, which is turned by the great wheel; and on the axis of this trundle is fixt the ratchet wheel N, into the teeth of which the catch O falls. P is the lever, from which goes a rope QQ over a pulley R, to the catch; the end of the rope being fixed into the lever and catch. S is an elastic bar of wood, of which, one end is screwed to the floor; and from the other end (out of sight in the figure) goes a rope to the farther end of the lever, beyond the pin or axis on which it turns in the upright supporter T. The use of this bar is to keep up the lever from rubbing against the edge of the wheel U, and to let the catch keep in the teeth of the ratchet-wheel. But, when the end P of the lever is pulled down, it lifts the catch out of the ratchet wheel by means of the rope QQ, and gives the weight F liberty to descend:

but if the lever be pulled a little farther down than what is sufficient to lift the catch out of the teeth of the wheel, it will rub against the edge of the wheel V, and thereby hinder the too quick descent of the weight; and will quite stop the weight if pulled hard. And if the man should happen inadvertently to let go the lever, the elastic bar will pull it suddenly up, and the catch will fall down into the wheel, and stop the machine.

W W are two upright rollers, above the axis or upper gudgeon of the gib E: their use is to let the rope bend upon them, as the gib is turned to either side, in order to bring the weight over the place to which it is intended to be let down.

N. B. The rollers ought to be so placed, that if the great rope were stretched close by their outermost sides, the half thickness of the rope may be perpendicularly over the center of the upper gudgeon of the gib. For then, and in no other position of the rollers, the length of the rope between the pulley in the gib and the axle of the great wheel will be always the same, in all positions of the gib; and the gib will remain in any position to which it is turned.

When either of the trundles is not used in working the crane, it may be drawn off from the wheel, after the pin near the axis of the trundle is drawn out, and the thick piece of wood is raised up a little, behind the outward supporter of the axis of the trundle. But this is not material: for, as the trundle has no friction on its axis but what is occasioned by its own weight, it will be turned by the wheel without any sensible resistance in working the crane.